Low summer streamflows in Massachusetts

The science of stream-aquifer interaction

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The role of the USGS Water Science Center in Massachusetts….

1. Operate the State's water-data infrastructure (streamgage and observation well network).

2. Conduct cooperative investigations to meet the State's scientific information needs in water resources.

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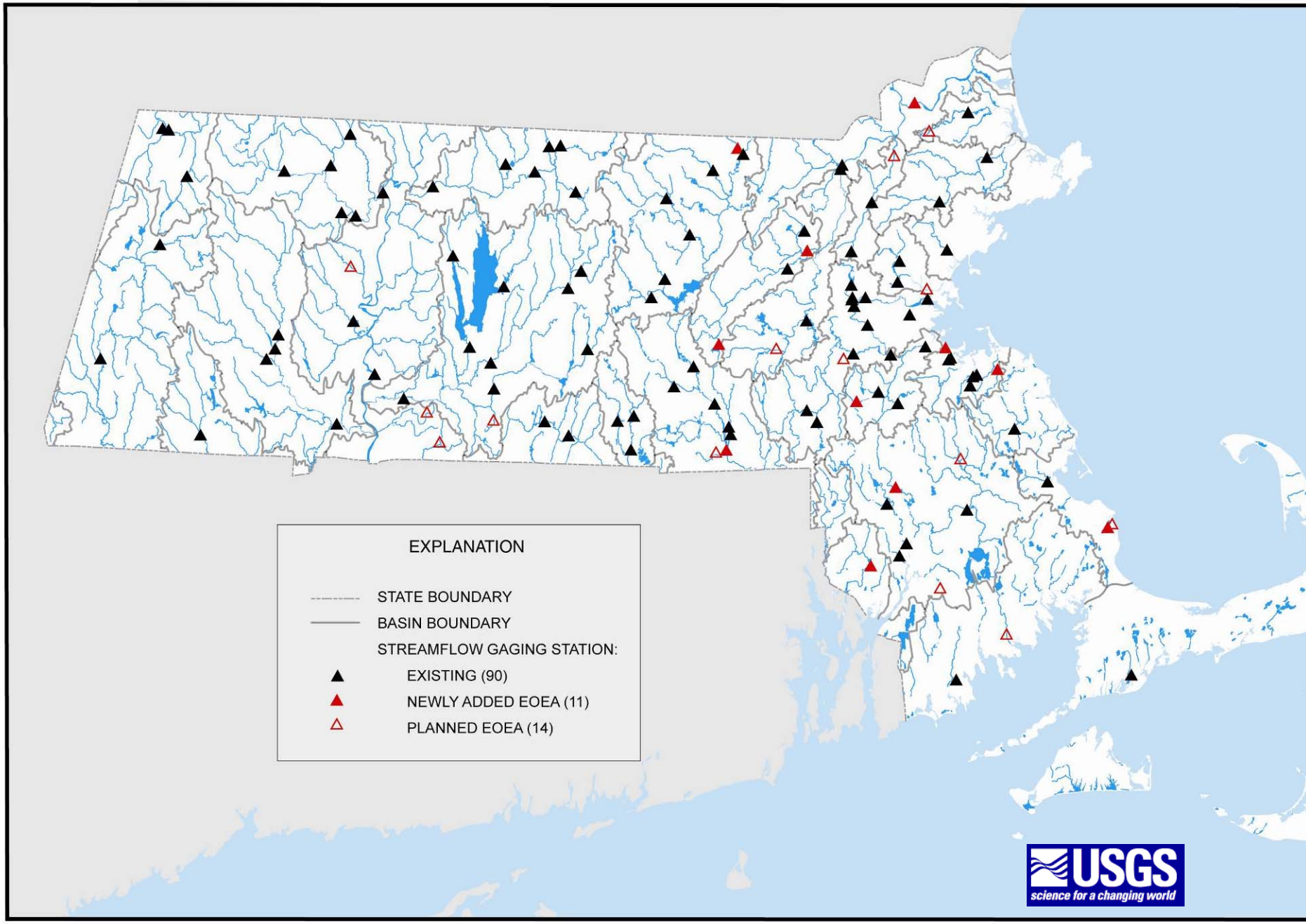
EXPLANATION
STATE BOUNDARY
BASIN BOUNDARY
STREAMFLOW GAGING STATION:
EXISTING (90)
NEWLY ADDED EOEA (11)
PLANNED EOEA (14)
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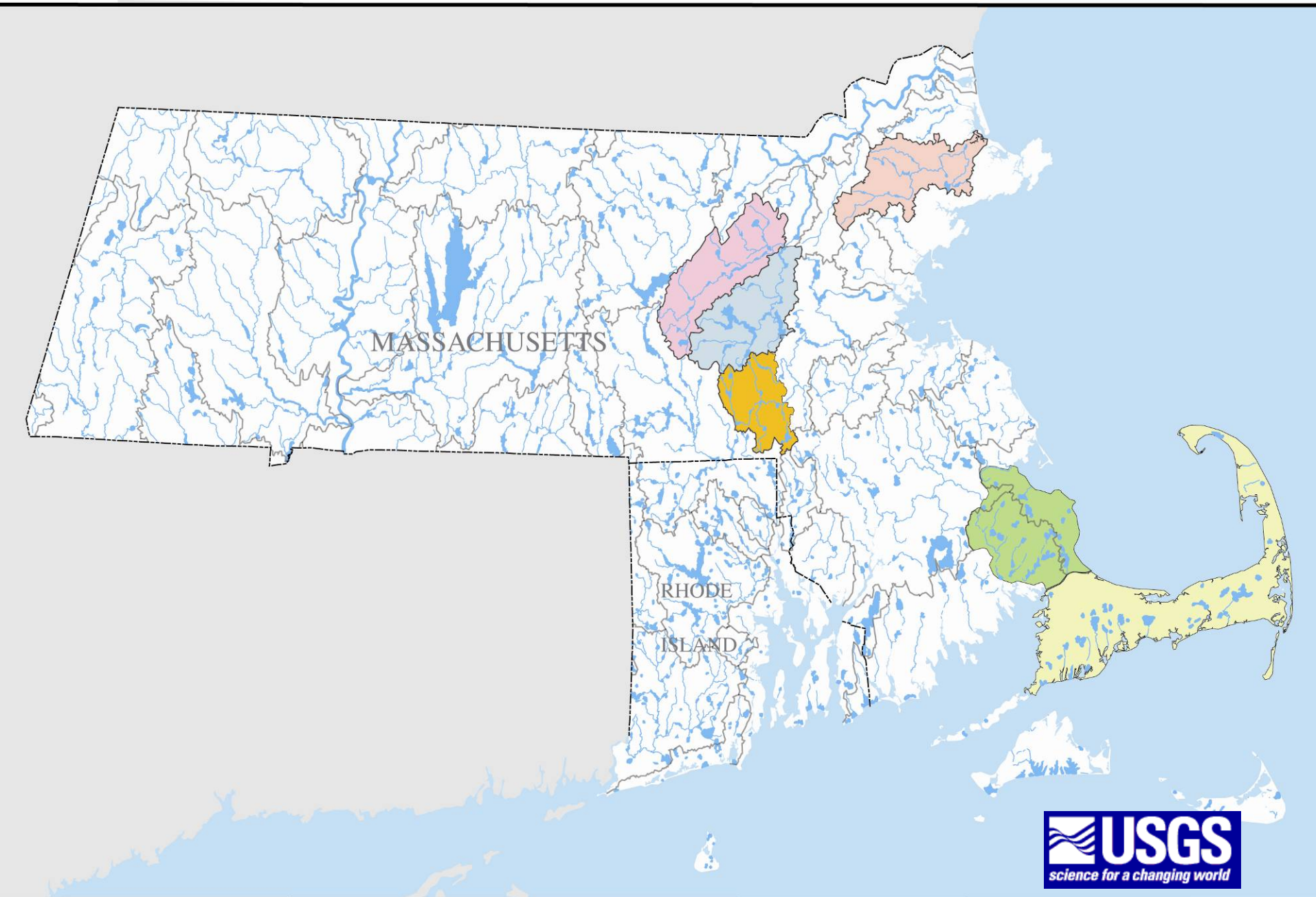

on Stream Flow Science

Streamflow at any location is the integrated result of numerous factors…

- Climate (precip and evapotranspiration)
- Hydrologic position (headwater vs. downstream)
- Geology and soils (permeable vs. impermeable)
- Water use (withdrawals and return flows)
- Land use & land cover (forested, open, residential, commercial/industrial)

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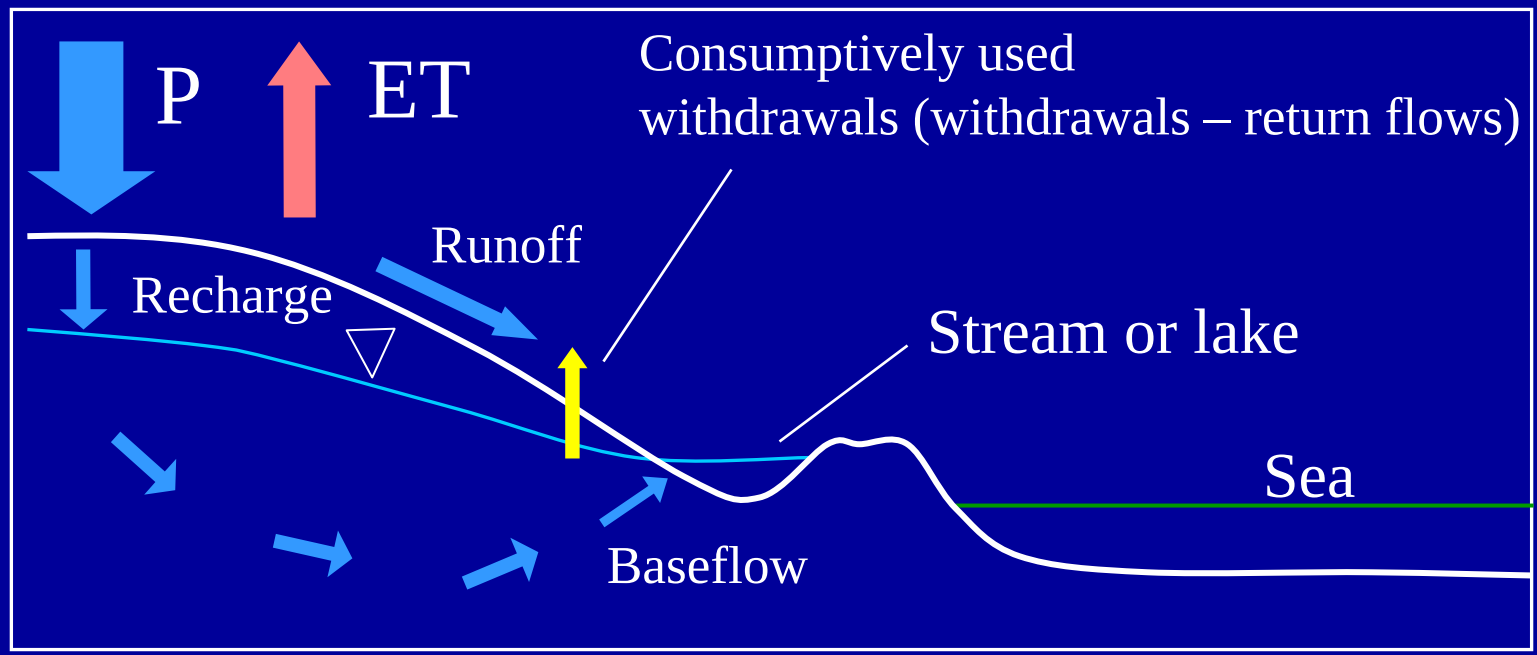
Massachusetts is “water rich”, right?…

- Abundant precip, moderate ET
- 11,742 miles of perennial streams



- On an *annual* basis, consumptive use is typically < 5% of stream baseflow in Massachusetts
- So what’s the problem?

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Here's the problem:

1. Precipitation is evenly distributed over time, but water availability (recharge, baseflow) is highly seasonal in Mass.

2. Consumptive use of water is seasonal and out of phase with recharge, affecting aquifer storage and baseflow.

3. Aquifer storage is typically quite limited in Mass..

4. Net export of water downstream (or out of basin) and inflow/infiltration are typical with existing infrastructure.

5. Land-use change has the potential to reduce recharge.

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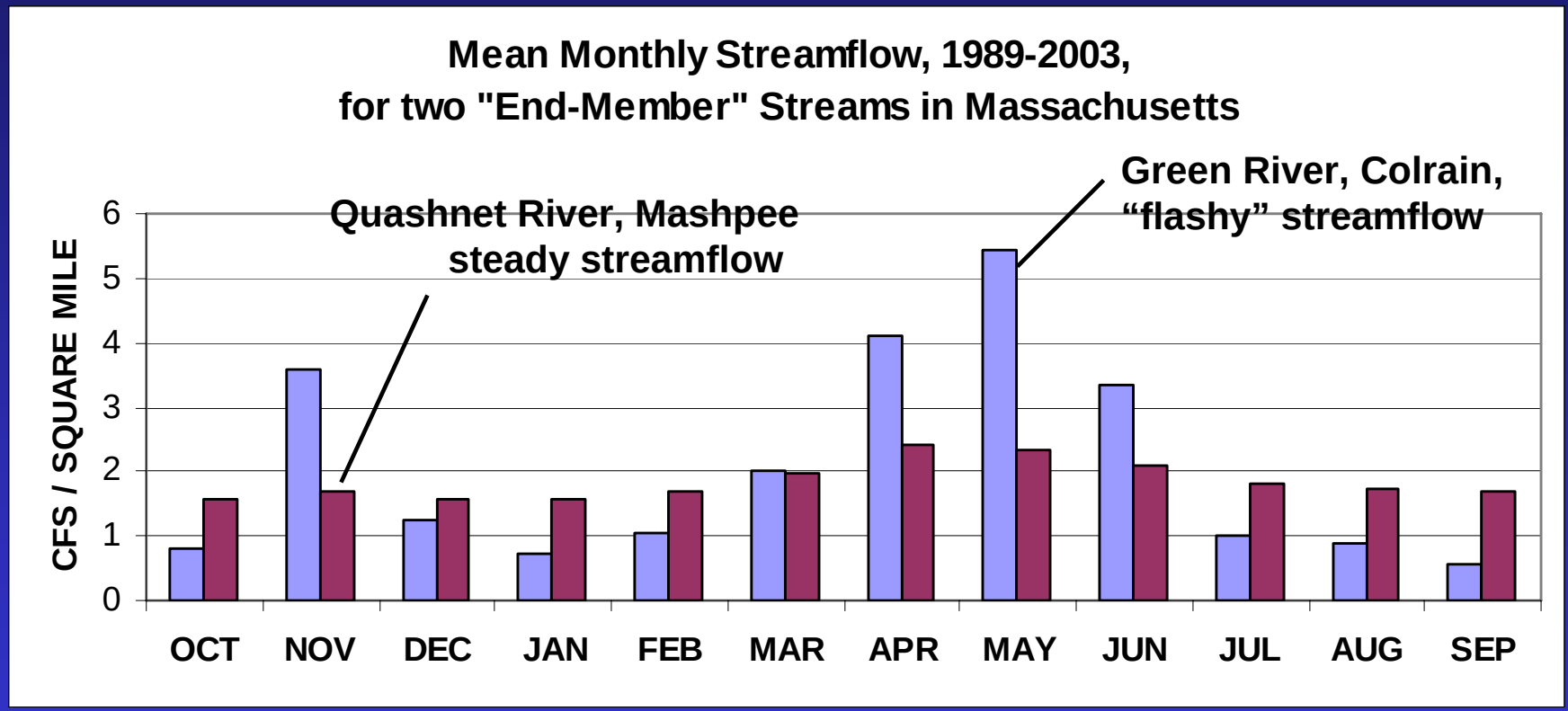
Seasonal character of natural water availability



Green River– Western MA, steep basin, till dominated, frozen soils in winter
Quashnet River– Coastal MA, flat basin, sand-dominated (high storage) temperate winter

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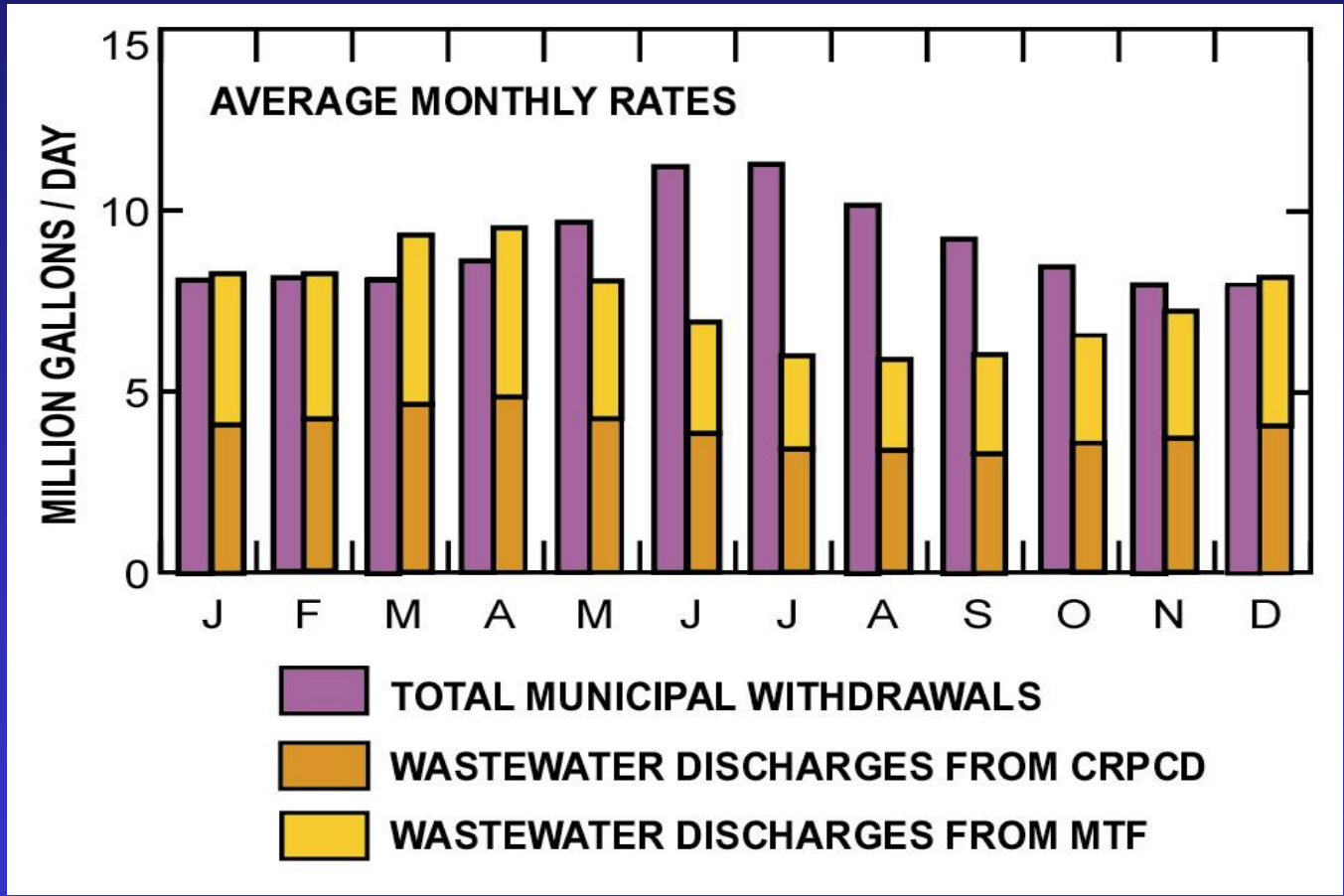
Seasonal character of withdrawals, returns, and inflow/infiltration:

Upper Charles Basin, 1989-98 average-monthly withdrawals & returns



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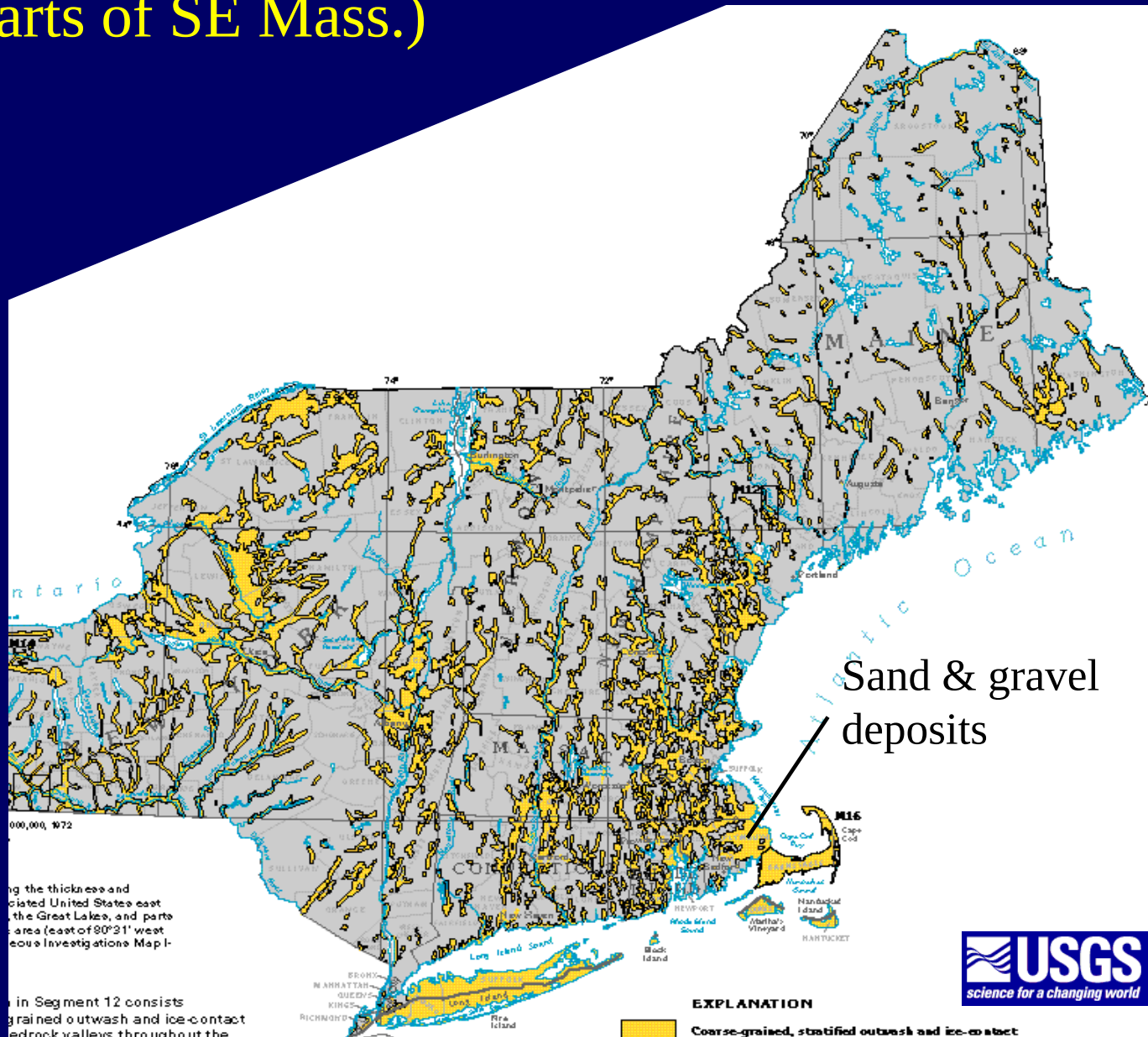
Limited aquifer storage:

(except for parts of SE Mass.)



Map from USGS Ground Water Atlas of the United States

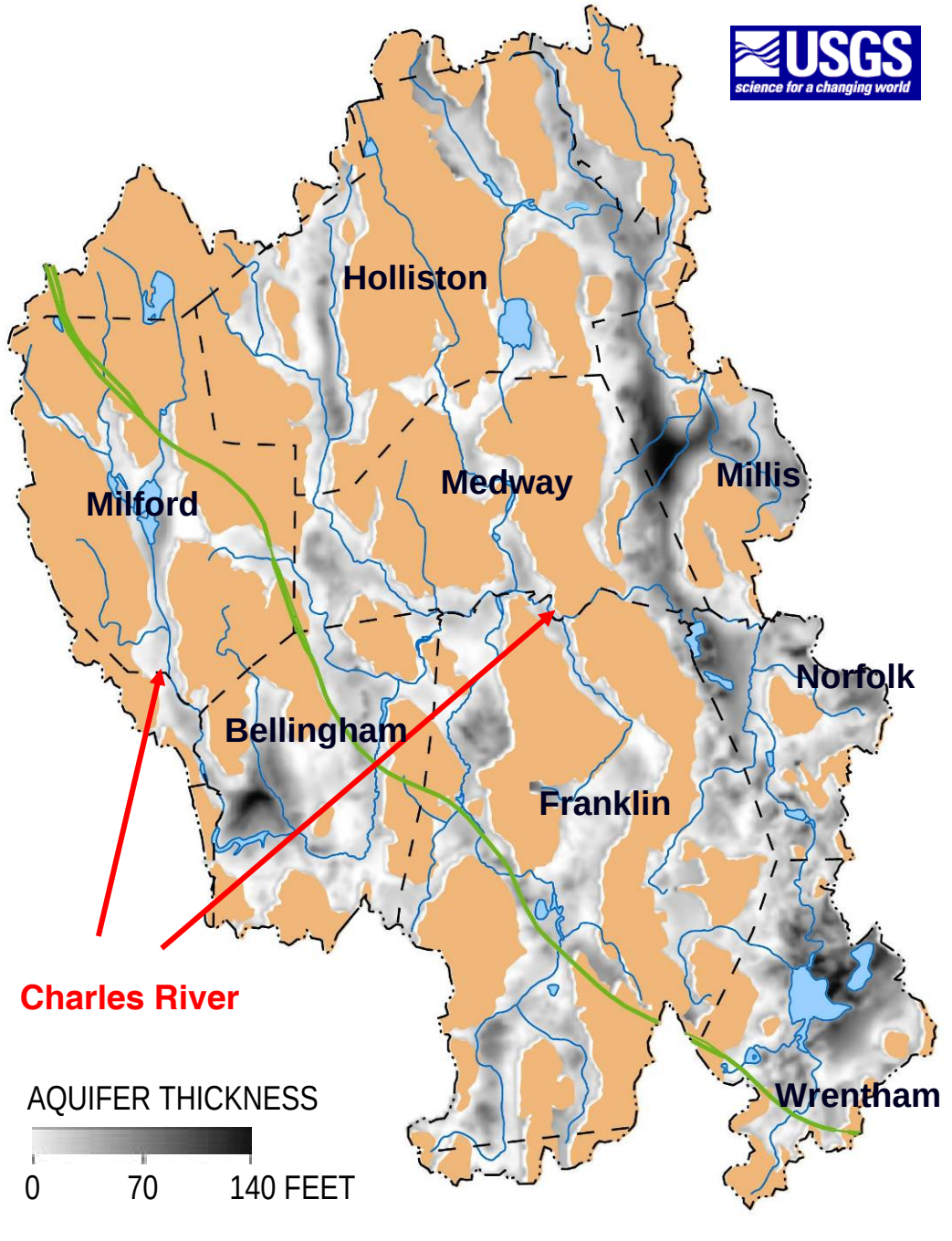
Aquifer storage

(cont.):

Upper Charles River Basin

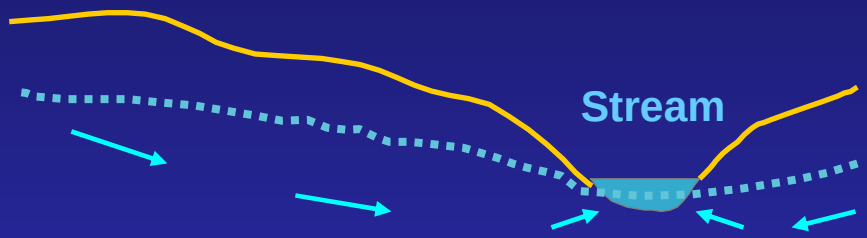
- Thin, discontinuous sand & gravel deposits
- In close hydraulic contact with streams, lakes, and wetlands

(DeSimone and others, 2002)

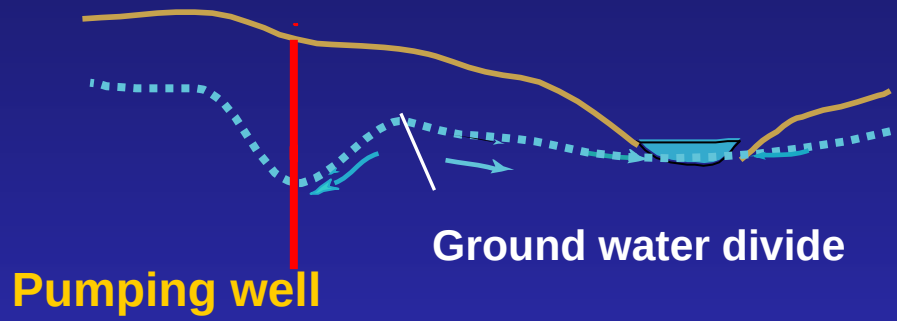


Streamflow depletion—one possible result of these interacting factors (seasonal water availibility, use, storage)

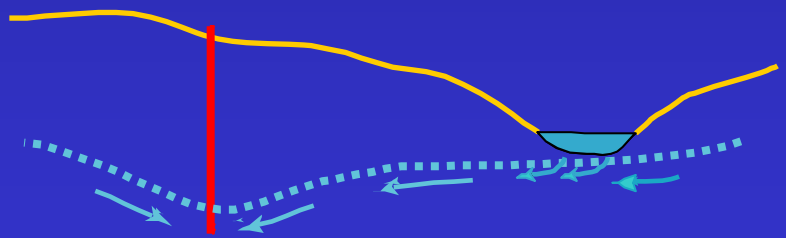
1. Pre-development



2. Captured baseflow



3. Captured baseflow + Induced infiltration



4. Depleted storage

(Zarriello and Ries, 2000)

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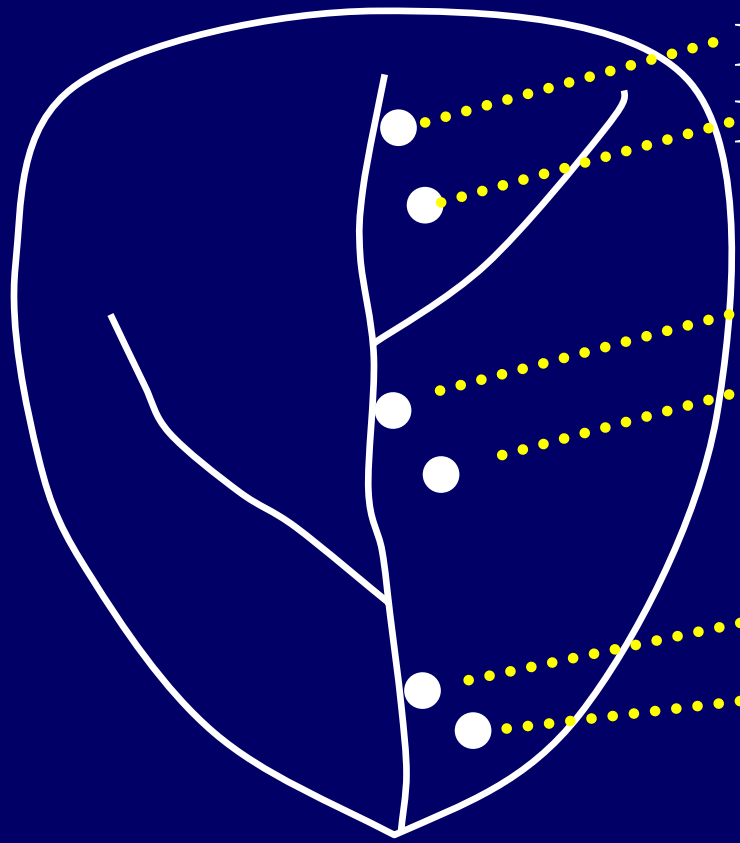
Relative effects of withdrawals upon streamflow-- Role of hydrologic position, well location



Management of summer low-flows will generally entail some combination of:

1. Increased recharge to aquifer (e.g., stormwater infiltration).

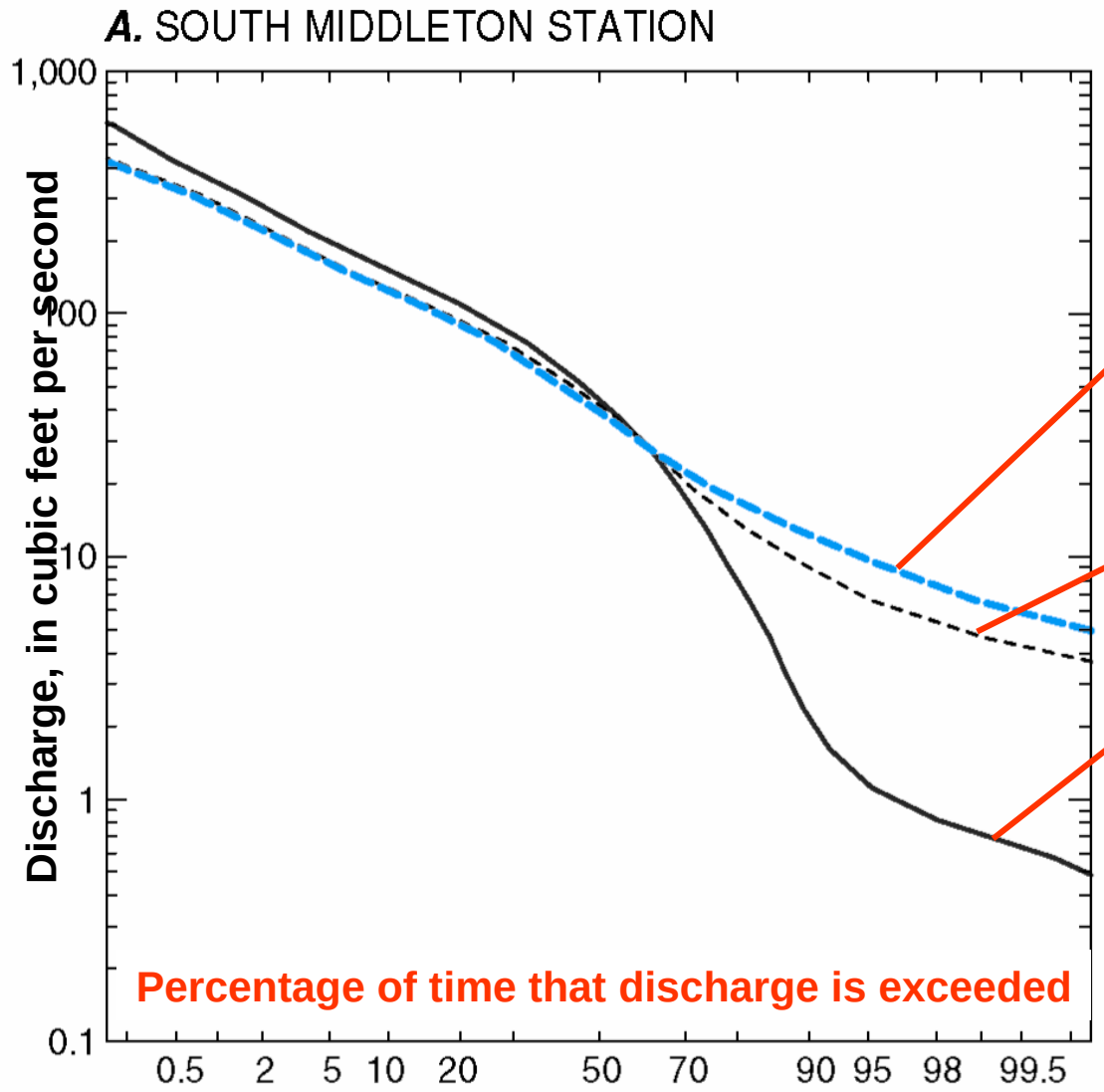
2. Bringing withdrawals more into phase with the recharge cycle (i.e., reduce summer demand management).

3. Reduce use of streamside wells in the summer; rely more upon aquifer (or reservoir) storage *away* from streams in summer.

4. Minimize export of water and wastewater.

Models are very useful for testing various options

Basin modeling: **Ipswich River at South Middleton**



Simulation results for:

No withdrawals, undeveloped land use

No withdrawals, 1991 land use

1989-93 withdrawals, 1991 land use

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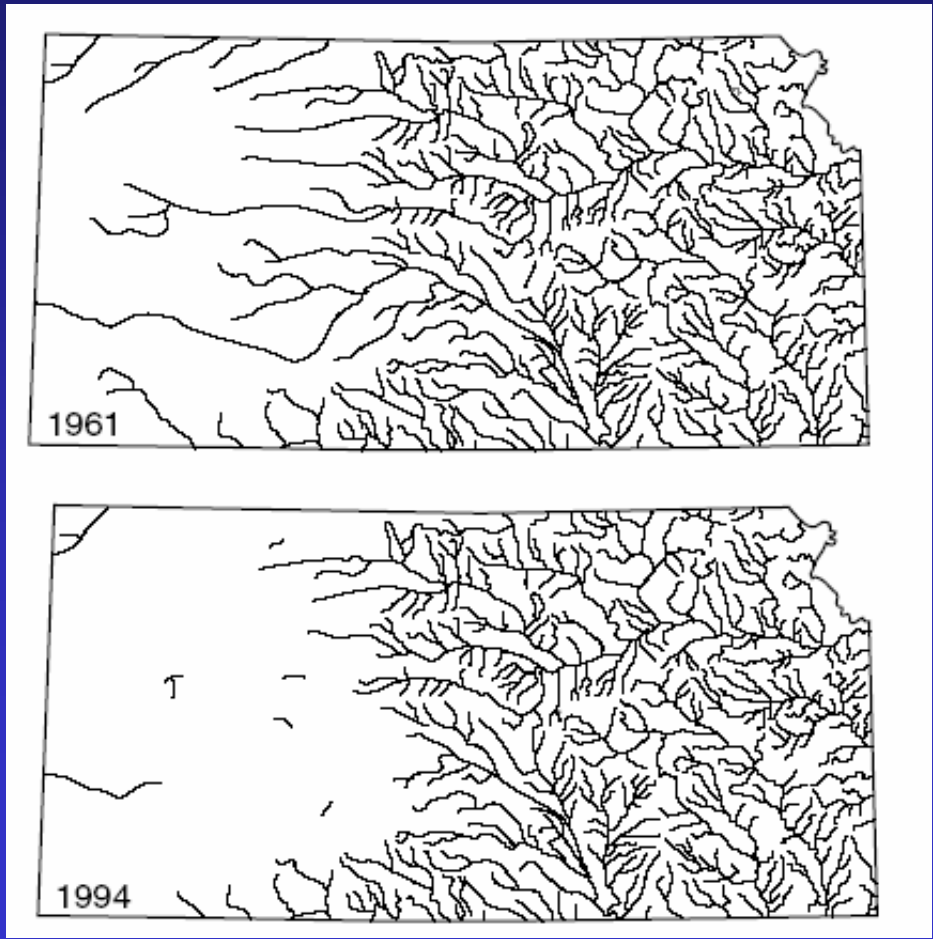
Also a critical issue at the national level…

Change in extent of perennial streams, Kansas: **1961**

1994



(Sophocleous, 2000)

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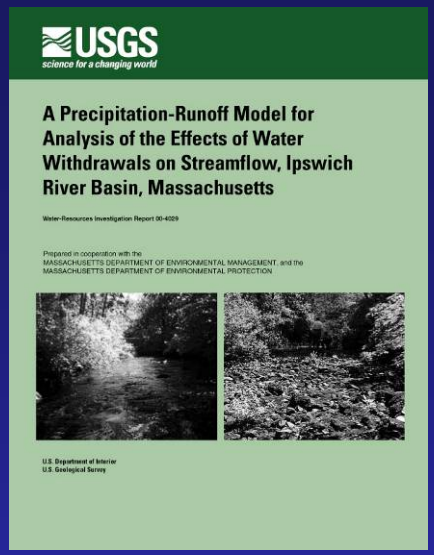
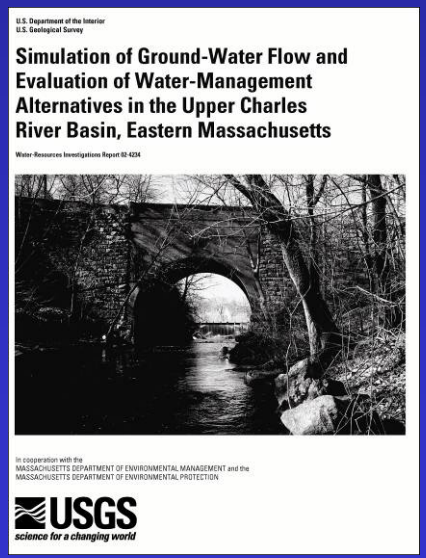


Recently completed USGS Basin Modeling Reports:

- Ipswich Basin
- Upper Charles Basin
- Assabet Basin
- Mid and Lower Cape



http://ma.water.usgs.gov (click on publications)

Current Studies in MA, (each with a Technical Advisory Committee)

- Sudbury Basin
- Plymouth/Carver Aquifer